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ABSTRACT

The purpose of this research memorandum is to describe a means of measuring racial balance and to apply the measure to the distribution of public school population in San Francisco. The measure is derived from the definition that full integration would be achieved if each school had exactly the citywide racial mixture of students. The racial balance index is so constructed that if every school had the citywide racial mixture, a value of 100 would result. If every school housed only one race (full segregation), a value of zero would result. Intermediate values reflect the degree to which the percentage of each race at each school varies from the citywide percentage of each race. This measure can also indicate not only the composite index for all four races (white, Spanish surname, black, and Oriental), but also the degree of integration achieved for an individual race. The measure takes into account school size. (Author/EB)

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Research Memorandum No. 1

MEASURING RACIAL BALANCE

Prepared for:

SAN FRANCISCO UNIFIED SCHOOL DISTRICT

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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FOREWORD

In September 1966, the San Francisco Unified School District contracted with Stanford Research Institute to study alternative means by which racial imbalance in San Francisco's public schools might be diminished. The following Research Memorandum is one of a series in which the Institute is presenting its findings.

The objectives of the study provide that the Institute form and evaluate several alternative patterns of pupil attendance that, if adopted, will result in the racial composition of individual schools more nearly reflecting the citywide racial distribution. The Institute also will evaluate the cost-effectiveness of the alternatives.

This memorandum on measuring racial balance is appropriately the first of the project reports. A measurement technique is essential if one is to learn whether proposed new attendance rules result in desegregation, and if so, to what extent. A measurement technique is also necessary to compare the effectiveness of alternative pupil assignment patterns.

The principal author of this Research Memorandum is Ben Lefkowitz. He was assisted by Tony D'Esopo. W. J. Platt, director of the Manpower, Education, and Research Group, was project leader.

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Summary

The purpose of this Research Memorandum is to describe a means of measuring racial balance and to apply the measure to the present distribution of public school population in San Francisco.

The measure is derived from the definition that full integration would be achieved if each school had exactly the citywide racial mixture of students. The racial balance index is so constructed that if every school had the citywide racial mixture, a value of 100 would result. If every school housed only one race (full segregation) a value of zero would result. Intermediate values reflect the degree to which the percentage of each race at each school varies from the citywide percentage of each race. The measure takes into account school size.

As an example, in 1966, San Francisco's public school population in junior high schools was 45.3% white, 11.8% Spanish surname, 25.8% Negro, and 17.1% Oriental. The 15 junior high schools vary in percentage white from 4.6% to 80.7% and in percentage Negro from 3.3% to 88.3%. Oriental and Spanish representation also vary by school. Taking into account the total deviations from proportional representation by race in each school, junior high schools as a group score 50.8 on the racial balance index scale.

Similar calculations have been made for elementary schools and for senior high schools. The three 1966 indexes are: elementary schools, 41.0; junior high schools, 50.8; and senior high schools, 60.6. The higher score for upper grade schools results from the larger attendance areas served by the bigger schools. The smaller attendance areas for the elementary schools reflect the more segregated neighborhoods they serve.

The racial balance index is so constructed that one can measure not only the composite index for all four races but also the degree of integration achieved for an individual race. The individual racial measure can help answer questions, such as to what degree do Negro students have the opportunity to attend integrated schools? In the case of junior high schools, 1966, the score for Negro-non-Negro students was 43.9 versus the composite score of 50.8.

The measure of racial balance will serve in SRI's study to compare the effectiveness of alternative patterns of pupil assignment.

> . . . when you can measure what you are speaking about, and express it in numbers, you know something about it; when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science . . .
>
> Lord Kelvin

Introduction

Before defining racial balance and constructing a metric (scale) by which this quality may be measured, it is important to distinguish between a scale and attitudes about values on a scale.

A measurement, no matter what the scale, is a neutral datum, although one's attitude toward it may not be neutral. For example, a person on a diet will not feel the same way about gaining five pounds as will a person recuperating from an illness.

The scales developed in this memorandum provide a means for measuring racial balance as it is defined here. Whether a particular measurement is "good" or "bad" depends on the observer's attitude toward school integration, and not on anything inherent in the scale.

Definition

By racial balance we mean the way in which white, Spanish surname (hereafter called "Spanish"), Negro, and Oriental students are distributed among the schools.

The key elements in this definition are the quadriracial categorization and the use of the school as the unit of aggregation. The number of races could be increased beyond four if there were significant representation of other ethnic groups in the school population. Similarly, a smaller aggregation unit than the school could be used--the grade or the classroom. Neither refinement, however, is warranted for the current study.

A desirable characteristic of a measure of racial balance would be the ability to consider the degree of integration present in the system from the standpoint of each race, i.e., Negro-non-Negro, white-nonwhite, and so forth. It is also desirable to have a composite measure, one that expresses the overall degree of integration achieved for the four dominant racial groups. The measures to be presented meet both requirements. For illustrative purposes, biracial measures are developed for the white-nonwhite category.

A Linear Measure of Racial Balance

One way to measure racial balance is to measure the magnitude of the deviations of the percentages of white students in the individual schools about the citywide white student percentage. To take into account varying school sizes, the individual deviations must be weighted by school enrollment. For any school, then, we can compute the weighted cross-product,

$$\begin{pmatrix}\text{School}\\ \text{enrollment}\end{pmatrix} \times \begin{pmatrix}\text{Absolute}\\ \text{value of}\end{pmatrix} \left(\begin{pmatrix}\text{Individual}\\ \text{white student}\\ \text{percentage}\end{pmatrix} - \begin{pmatrix}\text{Average}\\ \text{white student}\\ \text{percentage}\end{pmatrix} \right)$$

This number can be summed over all schools of the same type (e.g., junior high school) and the total is a measure, m, of racial balance for that system of schools. The same procedure can be applied to the Negro student percentage, or the Spanish or Oriental.

What is the range of the measure m?

Under complete integration, all schools would have identical white student percentages--the citywide average. This average would make all deviations zero and, consequently, the measure m would also be zero. Under complete segregation white students would go to one set of schools and nonwhite students to the remaining schools. In this arrangement, the white student percentage is 100% in the all white schools and zero percent in the nonwhite schools. Therefore, the maximum value that m may take on is

$$\begin{pmatrix}\text{Number}\\ \text{of white}\\ \text{students}\end{pmatrix} \times \left(100 - \begin{pmatrix}\text{Average}\\ \text{white student}\\ \text{percentage}\end{pmatrix} \right) + \begin{pmatrix}\text{Number of}\\ \text{nonwhite}\\ \text{students}\end{pmatrix} \times \begin{pmatrix}\text{Average}\\ \text{white student}\\ \text{percentage}\end{pmatrix}$$

If we divide the computed m value by the maximum m value, then the new, normalized measure will lie in the range 0-1; the low values will correspond to integrated schools, the high values to segregated schools.

Since higher numbers generally signify progress toward an objective, it seems appropriate to convert the racial balance measure so that the more integrated the schools, the higher the score. This relationship is achieved by subtracting the measure m, as computed above, from unity. The new measure will be identified as L. Now we have scaled the metric from zero to 100. The zero value would result from each school housing only one race (full segregation) and the 100 value would result from each school exactly reflecting the citywide racial composition for its type of school. An intermediate value of 70 may then be interpreted roughly as 70% integrated.

To summarize: the measure, L, of racial integration expressed as a percent is:

$$L = 100\% \times \left\{ 1 - \frac{\text{Sum of} \left(\begin{matrix}\text{School} \\ \text{enroll-} \\ \text{ment}\end{matrix} \right) \times \begin{matrix}\text{Magni-} \\ \text{tude of}\end{matrix} \left(\begin{matrix}\text{Individual} \\ \text{white student} \\ \text{percentage}\end{matrix} - \begin{matrix}\text{Average} \\ \text{white student} \\ \text{percentage}\end{matrix} \right)}{\left(\begin{matrix}\text{Number} \\ \text{of white} \\ \text{students}\end{matrix} \right) \times \left(100 - \begin{matrix}\text{Average} \\ \text{white} \\ \text{student} \\ \text{percentage}\end{matrix} \right) + \left(\begin{matrix}\text{Number of} \\ \text{nonwhite} \\ \text{students}\end{matrix} \right) \times \left(\begin{matrix}\text{Average} \\ \text{white} \\ \text{student} \\ \text{percentage}\end{matrix} \right)} \right\}$$

Example

We compute the L-value for a five-school system that has the following characteristics:

School	Number of White Students	Number of Nonwhite Students	Total Students	Percentage White
A	75	200	275	27.3%
B	100	200	300	33.3
C	250	200	450	55.6
D	275	200	475	57.9
E	300	200	500	60.0
Total	1,000	1,000	2,000	50.0%

The average white student percentage is 50% (1,000/2,000). The calculation of the sum of the weighted deviations (the numerator in the formula for L) is shown in the tabulation as:

School	Total Students	Absolute Deviation (%)	Weighted Deviation
A	275	22.7%	6,243
B	300	16.7	5,010
C	450	5.6	2,520
D	475	7.9	3,752
E	500	10.0	5,000
Total	2,000		22,525

The denominator in the formula for L is:

$$1{,}000 \times (100 - 50) + 1{,}000 \times 50 = 100{,}000.$$

Finally,

$$L = 100\% \times \left\{ 1 - \frac{22{,}525}{100{,}000} \right\} = 77\%.$$

This school system has a racial balance measure that is 77% of what would be achieved under complete integration.

A Quadratic Measure of Racial Balance

In the linear measure developed above, if two schools have the same enrollment, then a unit increase in the absolute deviation of either one will yield the same increase in the linear measure regardless of what the white student percentage is at either school. For instance, suppose the citywide white student percentage is 50%, and the white student percentage at one school is 60% and at another 80%. Then, the effect produced by an increase to 70% at the first school is the same as that produced by an increase to 90% at the second school.

A quadratic (root-mean-square) measure of racial balance takes into account the location of the increase; the more segregated a school, the greater the effect produced by a unit increase in segregation.

The quadratic measure of racial balance, Q, is:

$$Q = 100\% \times \left\{ 1 - \sqrt{\frac{\text{Sum of} \left(\begin{matrix}\text{School} \\ \text{enroll-} \\ \text{ment}\end{matrix} \right) \times \left(\begin{matrix}\text{Individual} \\ \text{white student} \\ \text{percentage}\end{matrix} - \begin{matrix}\text{Average} \\ \text{white student} \\ \text{percentage}\end{matrix} \right)^2}{\left(\begin{matrix}\text{Number} \\ \text{of white} \\ \text{students}\end{matrix} \right) \times \left(100 - \begin{matrix}\text{Average} \\ \text{white} \\ \text{student} \\ \text{percentage}\end{matrix} \right)^2 + \left(\begin{matrix}\text{Number of} \\ \text{nonwhite} \\ \text{students}\end{matrix} \right) \times \left(\begin{matrix}\text{Average} \\ \text{white} \\ \text{student} \\ \text{percentage}\end{matrix} \right)^2} } \right\}$$

Example

Using the same five-school system as before, we compute:

School	Enrollment	Squared Deviation	Weighted Squared Deviation
A	275	515.3	141,708
B	300	278.9	83,670
C	450	31.4	14,130
D	475	62.4	29,640
E	500	100.0	50,000
Total	2,000		319,148

The denominator in the formula for Q is:

$$1{,}000 \times (100 - 50)^2 + 1{,}000 \times (50)^2 = 5{,}000{,}000.$$

Finally,

$$Q = 100\% \times \left\{ 1 - \sqrt{\frac{319,148}{5,000,000}} \right\} = 75\%.$$

Henceforth we use the quadratic measure instead of the linear measure. We believe that the quadratic measure reflects penalties that should be associated with cases of extreme segregation better than does the linear measure.

Viewing Racial Balance from the Standpoint of Each Race

The example given above used the distinction of white-nonwhite. Essentially it answers the question: To what degree do white students in San Francisco have the opportunity to attend schools reflecting the citywide white-nonwhite biracial mixture? The same question can be asked from the viewpoint of Spanish-non-Spanish, Negro-non-Negro, or Oriental-non-Oriental categories. The calculation is the same, but the resulting values differ, reflecting the degree to which the particular race has the opportunity to attend schools where the racial mixture resembles the citywide average.

In Table 1 we show the quadratic measures for each race. At elementary school level, the Spanish student, in comparison with other races, has the best prospect of attending a partially integrated school, and the Negro the worst prospect. At junior high school level, Spanish students again attend more highly integrated schools than do Oriental and Negro students. Finally, at senior high school level, Spanish and Negro students attend schools that are more integrated than are schools Oriental students attend. The latter low figure is caused by the large Oriental enrollment in Galileo, a school with de facto segregation.

Table 1

RACIAL BALANCE INDEX,* 1966
San Francisco Unified School District
(On scale of 0 = segregation, 100 = integration)

Measure	Elementary Schools	Junior High Schools	Senior High Schools
White-nonwhite	45.57	56.12	61.89
Spanish-non-Spanish	56.39	60.51	69.55
Negro-non-Negro	28.48	43.94	65.19
Oriental-non-Oriental	39.07	43.82	49.88
Composite, four races	40.96	50.83	60.62

* Quadratic measure.

A Composite Measure--All Races

A single quadriracial measure is also useful to tell how integrated the entire system is. This composite measure is calculated from the four individual biracial measures by summing the four cross-products

$$\left(\begin{matrix}\text{biracial}\\ \text{quadratic}\\ \text{measure}\end{matrix}\right) \times \underbrace{\left\{\left(\begin{matrix}\text{citywide}\\ \text{racial}\\ \text{percentage}\end{matrix}\right)\left(1 - \begin{matrix}\text{citywide}\\ \text{racial}\\ \text{percentage}\end{matrix}\right)\right\}}_{A}$$

and dividing the total by the sum of the weights, A. The derivation of the weights used in the quadriracial index is shown in the Appendix.

The composite measure was calculated for the 1966 distribution of students. It is shown as the last "measure" in Table 1. As expected, the composite lies about mid point in the values of the individual races.

Appendix

DERIVATION OF A QUADRATIC QUADRIRACIAL MEASURE FROM BIRACIAL MEASURES

Let

$\bar{p}_j$ = citywide proportion of the j-th race

p_{ij} = proportion of the j-th race in the i-th school

N = total student population

N_i = number of students in the i-th school

N_j = number of students in the j-th race

The quadratic quadriracial measure is

$$Q = \frac{\Sigma_i N_i \Sigma_j (\bar{p}_j - p_{ij})^2}{\Sigma_j \left\{ N_j (1 - \bar{p}_j)^2 + (N - N_j)\bar{p}_j^2 \right\}}$$

Expanding the denominator, substituting $N\bar{p}_j$ for N_j, and simplifying

$$Q = \frac{\Sigma_i N_i \Sigma_j (\bar{p}_j - p_{ij})^2}{N\Sigma_j \bar{p}_j (1 - \bar{p}_j)}$$

The quadratic biracial measure after simplification is

$$Q_j = \frac{\Sigma_i N_i (\bar{p}_j - p_{ij})^2}{N\bar{p}_j (1 - \bar{p}_j)}$$

The quadratic quadriracial measure, then, is computed from the four biracial measures by weighting each biracial measure by the factor $\alpha_j = \bar{p}_j(1 - \bar{p}_j)$, summing the products, and dividing the total by $\Sigma_j \bar{p}_j (1 - \bar{p}_j)$.

Curiously, the same weights apply to the linear quadriracial measure.